A SIMPLE METHOD FOR THE STERILIZATION OF CATGUT.

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The successful sterilization of catgut means more than the destruction of the vitality of the adherent and contained micro-organisms, for asepticism must be conjoined with undiminished flexibility and tensile strength. Sterilization alone is easily accomplished, but the methods successfully employed to this end have, as a rule, been found to so seriously impair strength and flexibility as to be worthless for surgical purposes. Those which have proved best adapted to the desired end involve such considerable manipulation, or carry with them so many undesirable conditions, that a method simple in application and perfect in results has been the subject of considerable experiment.

The successful application of formaldehyde as a general disinfectant suggested to the writer that this agent might be of use in this particular direction, and in consequence a series of experiments was instituted. As will be noted, the first results, while most successful as to sterilization, were, in common with those of other methods, faulty in the directions above mentioned. Later experiments appear to have been completely successful.

Experiment I.—A lot of surgical instruments, including knives, probes, a director, forceps, needles, and scissors, all smeared with a culture of streptococcus, and six skeins of silkworm-gut and catgut, were placed in a glass cabinet of 200,000 c.c. capacity and subjected to the vapor of 5 c.c. formalin for four hours. Control cultures of each suture showed abundant growths. At the end of the exposure, cultures were taken from each object, and all proved sterile excepting the scissors, the blades of which had been tightly closed.

Experiment II.—Seventy-three skeins of catgut of assorted sizes, and three which had been soaked for two days in a bouillon culture of sporulating anthrax, were subjected for two and a half hours in the same cabinet to the same amount of formalin. Control cultures of each specimen showed abundant growths. Cultures taken directly after the exposure were sterile at the end of forty hours, with two exceptions. One yielded a long, non-pathogenic bacillus, and the other, from one of the skeins soaked in anthrax, yielded a mould. After seven days ten others showed moulds and yeasts.

Experiment III.—The preceding experiment was repeated, but with a longer exposure (seventy-two hours). No growths were observed until the tenth day, when three cultures yielded moulds. At the end of seventy-six days no further growths had occurred.

Experiment IV.—Six skeins of as many sizes of catgut were cut into inch pieces and soaked for five days in bouillon cultures of sporulating anthrax at 37.5° C. Half of them were then withdrawn and placed, in the wet condition, in open glass dishes in a horizontal glass cylinder of 1500 c.c. capacity, and subjected for twenty-four hours to the vapor of one and a half c.c of formalin. Two pieces of each size were then withdrawn and planted in bouillon. The remaining pieces were then again subjected to the same treatment for an additional twenty-four hours, when new cultures of each size were made, then to a third and fourth. The results of the cultures proved that from the first exposure all were sterile, no growths excepting an occasional one of mould being observed up to the fifty-fourth day, and these doubtless due to accident.

EXPERIMENT V.—The infected pieces not used in the preceding experiment were dried for twenty-four hours at 37.5° C. and subjected for three consecutive days to the action of the vapor of one c.c. formalin in the same manner. Controls showed profuse growths. At the end of each twenty-four hours two pieces of each size were planted. The only growths observed at the expiration of fifty days were four moulds.

EXPERIMENT VI.—In consequence of the growth of moulds in all these experiments, but with the belief that they must have been accidental contaminations from the cotton stoppers and from the air during the necessary manipulations, twenty-one different moulds were exposed for twenty-four hours to the action of one c.c. formalin in the same apparatus. At the end of the exposure every specimen was found to have been killed.

The foregoing experiments demonstrate that catgut which has been infected as thoroughly as is possible can be easily sterilized by formaldehyde. But what of its influence on strength and flexibility? To determine this question, skeins of each size were introduced into the cylinder and treated in the same manner with the same amounts of vaporized formalin. In each of the above experiments the formalin used was diluted with water before vaporization, and it was so treated in this instance. On introducing the agent, condensation of moisture was observed, and in a short time an accumulation of liquid occurred in the lower side of the cylinder. From day to day this was seen to diminish, and coincidently was observed a twisting of the skeins. In other words, the catgut was absorbing into its substance the diluted formalin. At the end of ten days the skeins were removed and tested. The smaller sizes were found to have been so affected that the mere tying of tight knots was sufficient to break them. The larger sizes, however, were found to have lost neither tensile strength nor flexibility.

EXPERIMENT VII.—In order to avoid the moisture, the next process tried was with paraform pastilles heated in a small Schering lamp connected, by means of a funnel having a bent stem, with the cylinder in which the skeins were placed. The further end of the cylinder was closed with a greased ground-glass plate, which, during the employment of the lamp, was moved laterally just enough to make a slight opening sufficient to allow the passage of the current of air impregnated with the vapors from the pastilles. The combustion of the alcohol required for their volatilization, however, gave rise to so much moisture in the cylinder that this method proved to be no better than the other.

The next process, than which nothing could be more simple and involve less trouble and manipulation, proved to be more successful.

Experiment VIII.—The greater part of a skein of catgut of medium size (No. 2) was placed in a salt-mouth jar of 1500 c.c. capacity, with a dozen paraform pastilles in a small beaker covered with fine copper gauze, and the jar was then closed with a tightly fitting stopper. The balance of the skein was set aside for strength-tests. Control cultures in bouillon yielded good growths. At the end of twenty-four, forty-eight, and seventy-two hours, the jar was opened, and small pieces were cut off and planted in bouillon tubes, and larger ones were withdrawn for strength-test. The results showed complete sterilization from the first day, and no loss of strength. The culture-tubes were kept in the thermostat thirty days, at the end of which time no growth whatever had occurred. The details of the strength-test will be found further on.

Experiment IX.—Three skeins of different sizes (0, 1, and 2) were cut into inch-pieces and soaked nine days at 37.5° C. in bouillon cultures of sporulating anthrax. Examination at the end of that time showed profuse growth, not only of anthrax, but also of streptococcus, moulds, and several other organisms, all of which must have been from original contamination of the catgut. The pieces were withdrawn from the culture-flasks, and half of them were placed in open glass dishes in an anatomical specimen-jar of 6000 c.c capacity, with a dozen pastilles in a beaker covered with copper gauze. The rest were dried overnight at 37.5° C. and then introduced with the others. Control cultures gave abundant growths. When the dry specimens were introduced, samples of the moist ones, which had then been exposed to the impregnated air for twenty-four hours, were taken and planted in bouillon. On each of the next three days, specimens of each size of both the moist and dry pieces were withdrawn and planted. The only growths which occured in the twenty-one cultures made were from two of the wet specimens taken at the end of the first day; all the others were completely sterile. No growth of any kind developed in the tubes during their forty days' stay in the thermostat. The results of this experiment demonstrate that the dry gas volatilized spontaneously from paraform pastilles has as great germicidal properties as the moist vapors from formalin.

In order to measure the action of the dry gas on the strength of the sutures, five skeins of sizes 00, 0, 1, 2, and 3 were placed in a similar jar, with the same number of pastilles, and confined ten days, when half of each was removed The rest were left in the jar ten days longer, and then removed.[1]

The results of the strength-tests indicate, so far as can be judged in the absence of a fixed normal standard of strength for each size, that neither tensile strength nor flexibility had been at all impaired. It is difficult and, indeed, impossible to state at what tension any specimen of catgut should break at the knot, for not only do different skeins of the same size give widely different averages, but the same skein yields no uniformity of results in its different parts. In attempting to ascertain the normal strength of the unsterilized gut, a number of skeins of each size were cut into pieces of equal length (15 cm.) and then these pieces in consecutive order, each with a single knot in the middle, were tested in the manner described below. As showing the absence of uniformity in the strength of the same skein, the following instances may be cited :

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[1] Since the above was written Experiment IX. has been repeated in all its details and with the same results. In order still further to test the exposed (sterilized) pieces of catgut, intraperitoneal and subcutaneous inoculations were made with them in guinea-pigs. No effects whatever were produced, the animals remaining perfectly healthy.

VARIATIONS IN STRENGTH OF CONSECUTIVE CUTTINGS OF SINGLE SKEINS.

The figures express the weight in grammes required to break the suture at the knot.

Size 00.	Skein *a.*	1660	2250	1295	1565	1315	1720
	Skein *b.*	1635	2445	1660	2465	1330	1330
Size 0.	Skein *a.*	1575	1810	1635	1600	2460	1915
	Skein *b.*	1475	2195	2225	1490	1065	2220
Size 1.	Skein *a.*	2120	1840	3045	2485	2575	3090
	Skein *b.*	4125	4940	5205	4480	4755	4225
	Skein *c.*	2980	3290	2325	3110	2730	3195
	Skein *d.*	5440	4680	5380	4425	5350	4905
Size 2.	Skein *a.*	5400	6275	5355	5850	7585	5915
	Skein *b.*	4225	3900	4205	4770	5225	4710
Size 3.	Skein *a.*	8845	6440	6420	7225	6990	8035
Size 4.	Skein *a.*	5710	3910	5200	3410	6525	5250
Size 5.	Skein *a.*	10875	8935	11210	9930	10175	8170

From the above figures it will be seen that in some cases the strength of two consecutive sections may vary very widely. Thus, pieces 2 and 3 of skein *a* of size 00 vary almost as 2 to 1 ; and pieces 5 and 6 of skein *b* of size 0 vary still more ; cuttings 2 and 3 of size 5 vary almost exactly five pounds ; 1 and 2 of size 3 over five pounds ; and 4 and 5 of size 4 nearly seven pounds.

As showing the difference in the averages obtained by breaking entire skeins cut in pieces of the same length, may be cited the following :

Size 00 . . .	1498	1636		
Size 0 . . .	1773	1999		
Size 1 . . .	2481	4276	3310	4975
Size 2 . . .	6180	5823	4169	5837

From the above it will be noted that not only do skeins of one size vary in a marked degree one from another, but a specimen of a large size (No. 3 of size 2) may be less strong than other skeins of a smaller size (Nos. 2 and 4 of size 1). Illustrative further of this latter is the fact that a skein of size 4 averaged only 4975, while one of the next smaller size (Size 3) averaged 7910—a difference of about six and a half pounds the wrong way.

Following are the averages obtained in the tests of strength of skeins of unsterilized and sterilized catgut, omitting the results of tests of the skeins whose strength was impaired by the wet process and by the heated pastilles.

	Unsterilized.	Sterilized.	
		10 days.	20 days.
Size 00	1498	1800	2596
	1636		
Size 0	1773	1679	1589
	1999		
Size 1	2481	2729	2565
	4276		
	3310		
	4975		
Size 2	5837	6886	6170
	6180	5993[1]	
	5823		
	4169		
Size 3	7910	7004	7162
Size 4	4975	5354[2]	
Size 5	9810	9333[2]	

Examination of these figures must lead to the conclusion that the method of dry sterilization with the solid paraform has probably no effect either way on the tensile strength of catgut. Owing to the objections already mentioned, no normal standard of strength can be fixed; but assuming for the moment that the figures obtained in this series might be so regarded, it would appear that the smallest size gains strength, the next loses but little, the next gains and loses as compared with different skeins, the fourth gains, and the fifth loses but little, and that the two largest sizes sterilized by the wet method respectively gain and lose. As a matter of fact, however, the results simply demonstrate that in each case the sterilized gut behaves as does the unsterilized. The same lack of uniformity was observed in both kinds. The main result may be thus stated: It is impossible to prove either a weakening or a strengthening, but whichever occurs, if either, the sterilized gut is suited to all the purposes for which it is intended.

The method employed in determining the tensile strength was as follows: An upright iron rod was securely fastened to a base, and at its upper end was screwed an arm carrying a horizontal ring through which was placed, point downward, a pair of parallel-jawed pincers, which was prevented from passing completely through by the spread of the handles. This pair served to hold securely the upper end of the knotted suture. A similar pair, passed upward through an iron ring fastened by a wire to the handle of a two-quart pail, grasped the lower end. When the whole was suspended from the upper ring, the handles were held in the rings in such a way that the greater the weight in the pail the tighter were the jaws of the two pincers closed on the interposed gut. In making a test, everything being in position, No. 5 shot was poured gradually from a lipped beaker into the pail until the suspended weight became great enough to break the gut at the knot. When this point was reached, the pail, its contents, and the lower pincers were transferred to a small platform-scale, sensitive to five grammes, and weighed. In 481 tests the catgut failed but once to break at the knot.

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[1] Average of skein used in Experiment 8.

[2] Sterilized by the wet method.

THE SURGICAL TREATMENT OF EPILEPSY,

WITH A REPORT OF FOURTEEN CASES.

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A feeling of uncertainty, perhaps even of scepticism, as regards the beneficial results of operations on the brain or its membranes seems to pervade in a large measure the medical profession. This feeling is not confined to the general practitioners, many of whom are apt to believe that death generally follows cerebral operations, or, if recovery should follow, that the patient is as often injured as benefited by the surgical procedure. It extends, also, to the neurologist and to the surgeon, both of whom are inclined to feel rather discouraged concerning the results of these operations. There must be a basis for the widespread prevalence of this feeling. It has arisen in part, I think, from the many lamentable failures and the numerous mistakes in diagnosis which occurred in the earlier days of cerebral surgery, when the rapid advance which was being then made in the knowledge of cerebral localization apparently opened up to the surgeon an extensive field for brilliant operative work and encouraged him to undertake operations which, at the present day, would seem unjustifiable. This anticipation has, unfortunately, not been realized, and some half dozen years ago a reaction began against cerebral operations, and the pendulum has not as yet swung back to its proper position.

It must be acknowledged, however, that even at the present day there is sufficient justification for this feeling of uncertainty. The results of operation are far from satisfactory; errors in diagnosis are still frequent, and permanent recovery is still almost the exception rather than the rule. It is very difficult to estimate correctly the dangers and the benefits of operations on the brain. Statistics on this, perhaps more than on any other surgical subject, are most unreliable. The successful